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CROSS DIRECTION FOR SUCCESSFUL PRODUCTION OF F_1 HYBRIDS BETWEEN *TRITICUM* AND *AEGILOPS* SPECIES

ABSTRACT

F_1 hybrids between *Triticum aestivum* L. (cv. Chinese Spring, Chinese Spring nulli 5B tetra 5D, cv. Roazon, cv. Rusałka, line CZR 1406), *Triticum durum* Desf. cv. Grandur, *Triticum turgidum* (L.) Thell. cv. Rampton Rivet and seven *Aegilops* species - *Ae. cylindrica* Host., *Ae. triuncialis* L., *Ae. variabilis* (*peregrina*) Eig., *Ae. ventricosa* Tausch., *Ae. crassa* Boiss. 6x, *Ae. juvenalis* (Thell.) Eig., *Ae. triaristata* Willd. 6x were obtained. In hybrid seeds endosperm was generally well developed but development of embryos varied from poor to almost normal developed. The hybrids were generated directly from immature embryos cultured *in vitro* . A total of thirty-eight F_1 plants were obtained. Crossability of *Aegilops* spp. as female with *Triticum* spp. was about seven times higher (15.30% on average) than in reciprocal crosses (1.99% on average).

Key words: *Aegilops*, cross direction, intergeneric hybrids, *Triticum*

INTRODUCTION

The cross of tetraploid or hexaploid wheat with various species of *Aegilops* genus serve commonly to introduction of resistance genes to diseases, unfavourable environment conditions and other traits from these wild grasses to *Triticum aestivum* L. A number of these genes have already been introgressed into *Triticum aestivum* L. from wild relatives (Feldman 1988).

The aim of this work was to analyse the effect of cross direction on crossing effectiveness in production of F_1 hybrids between *Triticum* and *Aegilops* species.

MATERIAL AND METHODS

The object of reciprocal crosses were five genotypes of common wheat *T. aestivum* L. (genomes AABBDD) - cv. Chinese Spring, Chinese Spring nulli 5B tetra 5D, cv. Roazon, cv. Rusałka, CZR 1406 (with

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translocation 1BL/1RS), *Triticum durum* Desf. cv. Grandur (AABB), *Triticum turgidum* (L.) Thell. cv. Rampton Rivet (AABB) and on other side *Aegilops* species - *Ae. cylindrica* Host. (CCDD), *Ae. triuncialis* L. (UUCC), *Ae. variabilis* (*peregrina*) Eig. (UUSS), *Ae. ventricosa* Tausch. (DDUnUn), *Ae. crassa* Boiss. 6x (DDMMSS), *Ae. juvenalis* (Thell.) Eig. (DDMMUU), *Ae. triaristata* Willd. 6x (UUMMUnUn). Crosses were obtained by standard methods for emasculation and pollination. Fourteen-day old hybrid embryos were isolated and placed on Murashige and Skoog's medium (1962). Embryo cultures were kept in the growth chamber at 24°C and exposed to illumination 6 W m^{-2} of light with a 16 h photoperiod. After 4 weeks the plants were transferred to the sterilized mixture of peat : sand : soil (1:1:1) in the mini-greenhouses and were fertilized with liquid nutrient containing macro- and microelements (Kaltsikes 1974). Subsequently after 6 weeks they were transferred into pots. The F_1 hybrid plants were vernalized in cool chambers for 6 weeks at 3°C. Thereafter, they were grown in greenhouse.

RESULTS AND DISCUSSION

Thomson (1930) hypothesised that the use of a female parent with a high chromosome number is more successful than the reciprocal cross. However in recent years, several wide hybrids were produced with female wheat component with low number of chromosomes. Sharma (1995) reported that several crosses between *Aegilops* and *Triticum* were rather successful provided a female parent has a low chromosome number . Maan (1987) informed that crosses involving *T. turgidum* and several diploids - *Ae. umbellulata* (UU), *Ae. uniaristata* (UnUn), *Ae. longissima* (S^1S^1), *Ae. bicornis* (S^bS^b) - produced only shrivelled and inviable seeds when diploides were used as males but the corresponding reciprocal crosses were successful. Chueca *et al. (*1977) observed that pollination of wheat *Triticum aestivum* cv. Chinese Spring with *Aegilops speltoides* (SS) pollen yielded very few, mostly abortive seeds, possibly due to degeneration of endosperm. These authors concluded that a high percentage of F_1 interspecific hybrids could be raised by cultures *in vitro* of immature embryos. Sharma (1995) was of the opinion that differences in success of cross direction with wide species can be due to chromosome imbalance in the endosperm, and suggested the role of male nucleus in endosperm development, or disturbance of endosperm development as a result of affecting antipodal cells by pollen which presumably supply nutrients during early endosperm development. Nishiyama and Inomata (1966) suggested that successful development of endosperm depended on the 2: 1 ratio of the maternal to paternal genomes in the endosperm.

In the present work *Aegilops* and *Triticum* plants possessing the same or different number of chromosomes were crossed. Irrespective of the ploidy level crossability was about seven-times higher when

Aegilops spp. maternal form was used (Table 1). In all combinations, endosperms and embryos were developed in hybrid seeds. The endosperm was generally well developed but embryos varied in size and shape from almost normal to poorly developed globular ones. Probably, it was due to bad interrelation of the embryo and endosperm in developing seed. Development of the embryo is interrelated with growing endosperm in the early stages but later the embryo becomes self-sufficient. The poorly developed embryos died under *in vitro* conditions.

Table 1

Results of crosses between *Aegilops* spp. and *Triticum* spp.

Cross combination	No. of florets pollinated	No. of seed set	Cross-ability [%]	No. of obtained F_1 plants	Success rate [%]
Ae. cylindrica × Chinese Spring	56	18	32.14	8	14.29
Reciprocal	108	9	8.33	6	5.56
Ae. juvenalis × CZR 1406	51	21	41.18	7	13.73
Reciprocal	108	1	0.93	1	0.93
Ae. triaristata 6x × Roazon	70	6	8.57	4	5.71
Reciprocal	96	2	2.08	0	0.00
Ae. juvenalis × Chinese Spring (N5BT5D)	44	0	0.00	0	0.00
Reciprocal	112	4	3.57	3	2.68
Ae. ventricosa × Grandur	30	5	16.67	3	10.00
Reciprocal	98	0	0.00	0	0.00
Ae.crassa 6x × Rusałka	44	4	9.09	3	6.82
Reciprocal	94	0	0.00	0	0.00
Ae.variabilis (pereg.) × Rampton Rivet	36	3	8.33	2	5.56
Reciprocal	98	0	0.00	0	0.00
Ae.triuncialis × Rampton Rivet	48	1	2.08	1	2.08
Reciprocal	92	0	0.00	0	0.00
Aegilops spp. × Triticum spp.	379	58	15.30	28	7.39
Triticum spp. × Aegilops spp.	806	16	1.99	10	1.24

The highest crossability was recorded when the spikes of *Ae. juvenalis* were pollinated with the pollen of wheat CZR 1406 (41.18%) or pollination of *Ae. cylindrica* with Chinese Spring wheat (32.14%). Sharma (1995) suggested that the crosses may be more effective if both parental species have common genomes. In our experiment *Ae. cylindrica* and *Ae. juvenalis* possess genome D homologous to D genomes of a common wheat *T. aestivum* (Sears 1981). However, the extent of genome D homology of these two species is different in genome D of *Ae. squarrosa* L. (the donor of D genomes in wheats) than that of *T. aestivum*. Kimber and Zhao (1983) reported that genomes D of *Ae. cylindrica* reveal high homology with *T. aestivum* and *Ae. squarrosa*, whereas genomes D of *Ae. juvenalis* are modified in a significant way. Hence high crossability between Chinese Spring and *Ae. cylindrica* in reciprocal crosses (8.33%) was recorded. Generally in the rest of reciprocal combinations the crossability was very low and ranged from 0% to 3.51%.

Kimber and Feldman (1987) informed that in favourable conditions *Ae. cylindrica* and *Ae. ventricosa* may cross spontaneously with the cultivated species of hexaploid wheat. According to Dosba (1985), F_1 hybrids between various species of tetraploid wheats and *Ae. ventricosa* are quite frequent if *Aegilops* is a female component. This study confirmed a high crossability of *Ae. cylindrica* and *Ae. juvenalis* with wheat. In case of other crosses of *Aegilops* with wheats, hybrid plants were only obtained when *Aegilops* species were used as female plants. Succesfull reciprocal combination between *Ae. juvenalis* and Chinese Spring nulli 5B tetra 5D, was an exception since hybrid plants were obtained when *Aegilops* was used as a pollinator.

A total of 38 F_1 plants were obtained from all combinations (28 F_1 *Aegilops* × *Triticum* plants and 10 reciprocal combinations). Contrary to the seed set being higher when *Aegilops* was used as the female, the ability to grow plants from immature embryos by cultures *in vitro* was higher when wheat was fertilized with *Aegilops* pollen. The final success rate (green plant per 100 polinated florets) was still higher when *Aegilops* served as the female and wheat - as the pollen parent.

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